CLAIMS

1. A quantum cascade laser, comprising:

an active region for generating lasing radiation in a frequency range of about 1 to about 10 Terahertz, and

a waveguide formed of an upper metallic layer and a lower metallic layer, each layer being disposed on a surface of said active region so as to confine selected modes of said lasing radiation within said active region.

2. The quantum cascade laser for claim 1, wherein said waveguide provides a mode confinement factor of about 1.

3. The quantum cascade laser of claim 1, wherein each of said metallic layers has a thickness in a range of about 0.1 to about several microns

4. The quantum cascade laser of claim 1, wherein at least one of said metallic layers comprises a single layer structure formed of a selected metallic compound.

5. The quantum cascade laser of claim 1, wherein at least one of said metallic layers comprises a multi-layer structure, the layers being formed by at least two different metallic compounds.

6. The quantum cascade laser of claim 4, wherein at least one of said metallic layers comprises a layer of gold.

7. The quantum cascade laser of claim 5, wherein at least one of said metallic layers comprises a layer of gold disposed over a layer of titanium.

8. The quantum cascade laser of claim 1, wherein said active region comprises a semiconductor heterostructure providing a plurality of lasing modules connected in series.

9. The quantum cascade laser of claim 4, wherein each lasing module comprises

a plurality of quantum well structures collectively generating at least an upper lasing state, a lower lasing state, and a relaxation state such that said upper and lower lasing states are separated by an energy corresponding to an optical frequency in a range of about 1 to about 10 Terahertz, and

wherein electrons populating said lower lasing state exhibit a non-radiative relaxation via resonant emission of LO-phonons into said relaxation state.

10. The quantum cascade laser of claim 1, further comprising two contact layers each disposed between a surface of said semiconductor heterostructure and one of said metallic layers.

11. The quantum cascade laser of claim 10, wherein each contact layer comprises a heavily doped semiconductor.

12. The quantum cascade laser of claim 11, wherein said heavily doped semiconductor layer comprises a GaAs layer having a doping level of about 10^{18} cm^{-3}.

13. The quantum cascade laser of claim 9, wherein said semiconductor heterostructure is formed as alternating layers of GaAs and $Al_{0.15}Ga_{0.85}As$.

14. The quantum cascade laser of claim 9, wherein a vertical optical transition between said upper lasing state and said lower lasing state generates lasing radiation in a range of about 1 THz to about 10 THz.

15. A method of confining a mode profile of radiation in a quantum cascade laser, comprising:

disposing an active region of said quantum cascade laser between an upper metallic layer and a lower metallic layer,

wherein each metallic layer has a thickness larger than a skin depth of radiation in a frequency range of about 1 THz to about 10 THz in said metallic layer.

16. The method of claim 15, further comprising depositing at least one of said metallic layers on a surface of said active region by employing molecular beam epitaxy.

17. The method of claim 15, further comprising employing a wafer bonding technique to generate said upper and lower metallic layers.

18. A Terahertz amplifier, comprising

an amplification region for amplifying an incoming radiation signal having a frequency in a range of about 1 THz to about 10 THz to generate an amplified signal,

an input port for coupling said incoming radiation into said amplification region,

an exit port for extracting said amplified signal from said amplification region, and

a waveguide formed of an upper and a lower metallic layer diposed on opposing surfaces of said amplification region to confine radiation within said amplification region.